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How Cyclical Is the User Cost of Labor?

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Abstract

In employment relationships, a wage is an installment payment on an implicit long-term agreement between a worker and a firm. The price of labor that impacts firm's hiring decisions, instead, reflects the hiring wage as well as the impact of economic conditions at the time of hiring on future wages. Measured by the labor's user cost, the price of labor is substantially more pro-cyclical than the new-hire wage or the average wage. The strong procyclicality of the price of labor calls for other forces for cyclical labor demand to explain employment fluctuations.

Keywords: User Cost of Labor. Wages. Cyclicality. Wage Rigidity. Unemployment.

JEL: E24, E32, J30, J41, J63, J64.

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Macroeconomists have long been interested in the cyclical behavior of real wages, as part of the task of disentangling sources of employment fluctuations during the business cycle. For example, in the second half of the 1930s, John Maynard Keynes argued (in agreement with the earlier generation of neoclassical economists) that economic expansions tended to drive down real wages because in an expansion the price level tended to rise more quickly than nominal wages. In his view, real wages were countercyclical. On the other side, John Dunlop and Lorie Tarshis carried out empirical analysis suggesting that real wages instead were procyclical—a finding that Keynes seemed open to accepting (for an overview of the debate in this journal, see Dunlop 1998).

To understand what is at stake, consider a textbook model of the aggregate labor market with a downward-sloping labor demand and an upward-sloping labor supply curve. At an initial equilibrium, labor demand equals labor supply at some wage and some level of employment. We know that the quantity of labor falls during a recession. In one class of models, a cyclical decline in employment happens from a shift to the left in labor supply along the stable labor demand curve and is accompanied by an increase in wages. The result is a Keynesian countercyclical real wage, in which a reduction in employment in recessions is accompanied by a rise in real wages. In a different class of models, the cyclical decline in quantity of employment happens via a shift of the labor demand curve to the left. In this case, a recession is accompanied by a decline in wages—that is, a procyclical real wage. That is, the quantity of labor could decline as a result of a shift in either labor demand or labor supply—but these explanations have different implications for the cyclicality of real wages. Economists measure the cyclicality of a given data series by the degree to which it co-moves with a measure of the business cycle, for example, a (detrended) unemployment rate.

In many standard macroeconomics models, a rigid (or countercyclical) wage is the key to generating employment fluctuations. If, instead, real wage is strongly procyclical—as I will argue in this paper—one needs to look for other factors to explain the large declines in employment that happen in recessions.

In the next section, I discuss that the early literature, which took the average real wage as the measure of real marginal cost of labor, found it almost acyclical. However, an aggregate wage can change for two reasons during the business cycle: an actual change in the wage and/or a shift in the composition of the labor force. If one adjusts for the fact that lower-wage workers are more likely to exit the labor force in a recession, the resulting composition-adjusted wage is procyclical. A further distinction between wages of incumbent workers and wages of newly hired workers, shows that wages of newly hired workers are considerably more procyclical than the average wage. Each of these subsequent refinements of wage is more procyclical than an average wage.

The rest of the paper explains why the observed wage does not capture the appropriate economic concept, which is the real marginal cost of labor, and how the price of labor can be much more procyclical than the average wage or even the new hire wage. In long-term labor relationships, neither an average wage nor the new hire wage fully captures the price of labor. As Hall (1980, p. 101) writes: ``[T]o see what is happening today in the labor market, one should look at the implicit asset prices of labor contracts recently negotiated, not at the average rate of compensation paid to all

workers." The expected long- term nature of the relationship allows the firm to smooth some potential fluctuations in worker wages over time. Therefore, the current wage does not capture the contemporaneous cost of a worker to a firm. I will introduce the concept of the user cost of labor (Kudlyak, 2014), an analog to the user cost of capital, as a way to measure a price of any long-term-use asset. In this view, the wage is simply an instalment payment on an implicit long-term agreement between a worker and a firm. I then argue that it is the user cost of labor and not a per period wage that plays a role in firm hiring decisions. I will discuss that it is quite possible to have average wages that appear rigid during the business cycle and also to have a user cost of labor that is highly procyclical. I also discuss a measurement issue associated with cyclical changes in labor's price: the possibility of confounding effects of cyclical variation in the quality of labor matches created at different points during the business cycle, an issue distinct from the composition effect mentioned above.

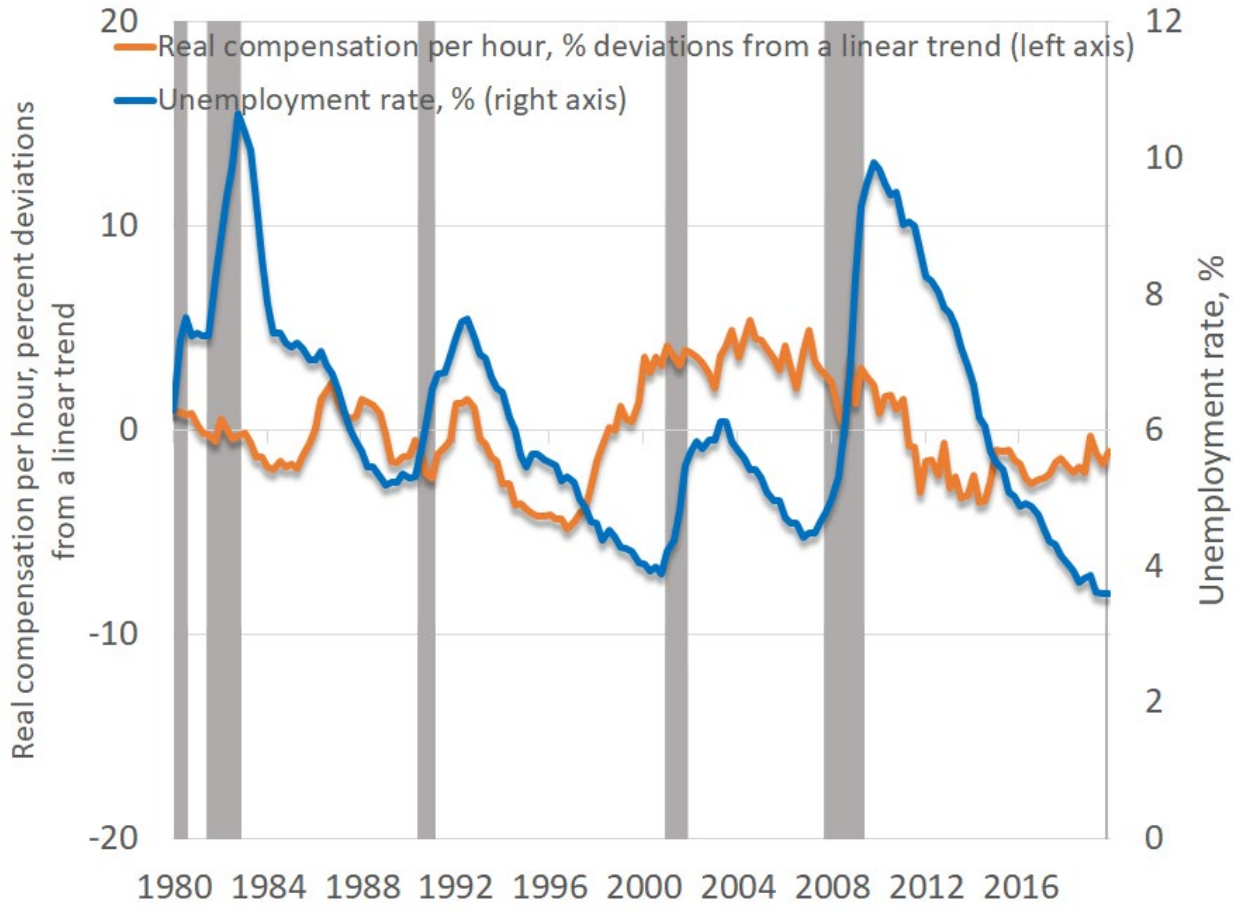
With these conceptual building blocks in place for how to think about the price of labor, I describe recent estimates of the cyclicality of the price of labor as estimated by the cyclicality of the user cost. Recent work estimates that the price of labor is strongly procyclical, declining by more than 4.5 percent when unemployment increases by one percentage point (Bils, Kudlyak and Lins 2023). This evidence of a strongly procyclical price of labor raises open research questions of how to model labor markets in a way that leads to the observed variations in employment over the business cycle.

Cyclicality of the Average Wage, Wages of Workers in Ongoing Relationships and Wages of New Hires

An early literature took the actual average real wage in the economy as the measure of real marginal cost of labor (for example, Mankiw, Rotemberg and Summers 1985). The average wage is almost acyclical. Figure 1 shows big unemployment increases during recession but no corresponding declines in the average wage. This observation led to a conclusion that the price of labor over the business cycle was rigid: that is, it falls little or not at all during recessions and rises little or not at all during cyclical booms.

Changes of the average wage, however, reflect both the changes of wages of individual workers and also changes in the composition of the workforce. For example, recessions are times when low-wage workers tend to leave the workforce, while economic booms are the times when low-wages workers tend to be more widely represented in the workforce. Such countercyclical movements in the composition of workforce, in terms of their typical relative wages, will affect the average wage.

Figure 1. Real Compensation Per Hour and Unemployment Rate



Notes: The figure shows compensation per hour in the nonfarm business sector adjusted for inflation by changes in the CPI-U and the unemployment rate. The compensation series are expressed as ln-deviations from a linear trend. Quarterly, seasonally adjusted series, 1980-2019. Source: U.S. Bureau of Labor Statistics.

A literature has sought to disentangle the cyclicality of wages from cyclical changes of the composition of the workforce.[1] Starting from Bils (1985), this literature turned to examining cyclicality of wages of individual workers, without aggregating. An analysis of the cyclicality of individual wages is conducted with the panel data, which contains observations about a cross-section of workers over time. The individual-level panel data allow not only controlling for observable worker characteristics, such as education or age, but also for unobservable worker fixed effects. Using the panel data on young men from 1966 to 1980, Bils finds real wages to be very procyclical---a percentage point rise in the unemployment rate is associated with a decrease in real wages of between 1.5 and 2 percent.

[1]The argument about the composition bias is first mentioned in Stockman (1983). See also Solon, Barsky, and Parker (1994).

More recently, the composition effect in wages is demonstrated in Cajner, Crane, Decker, Grigsby, Hamins-Puertolas, Hurst and Kurz (2020). Using weekly administrative payroll data from a large U.S. payroll processing company, they show that during the 2020 pandemic recession average (nominal) wages increased by nearly 6 percent through mid-May; however, the entire growth was attributed to the changing composition of workers (see their Figure 5). Specifically, they show that at the onset of the pandemic, workers at the bottom of the wage distribution were much more likely to experience employment reductions than those at the top of the wage distribution. Consequently, from March through the end of April 2020, the workforce became more selected towards higher-wage workers, while the reverse happened thereafter.

In addition to estimating the cyclicality of individual wages, another marked advance of Bils (1985) is a distinction between wages of the job stayers who remain with the same employer versus wages of the job changers who are moving between employers or in and out of the workforce. Bils documents a significantly greater procyclicality of wages of job changers, relative to wages of job stayers. Specifically, as the unemployment rate goes up by one percentage point, wages of newly hired workers decrease by 3 percent, while wages in ongoing relationships decrease by less than 1 percent. This finding is of marked interest, as Bils notes, if it is really these more transient workers who reflect cyclical changes in supply and demand in the labor market.

Bringing this evidence to the analysis of the canonical search and matching model of the labor market, Pissarides (2009) discusses how job creation is influenced by wages in new matches. To the extent that the new hire wage captures the marginal price of labor, the relevant price of labor for job creation is more procyclical than what is implied by the cyclicality of the average wage. However, as I argue below, the new hire wage does not fully capture the price of labor.

Pricing Labor by Its User Cost

History-Dependence of Wages

Employment relationships are often long-term. In a long-term relationship, the wage observed in a relationship---either the new-hire or the average wage---may not capture the true price of labor. Instead, in long-term agreement, the current wage is a per-period payment within the context of an implicit agreement between a worker and a firm; and that payment does not necessarily equal the period's marginal cost of worker.

This insight is illustrated by a fact pattern described in the previous section: wages of newly hired workers are substantially more procyclical than wages of workers in ongoing relationships. Moreover, individual wages exhibit dependence on the history of economic conditions since the start of the match (for example, Beaudry and DiNardo (1991) and von Wachter (2020)). Taken together, these observations imply that the wage alone does not summarize the wage commitment

a firm makes upon hiring a worker. Adding a worker in one period, rather than in the following period, may affect not only the wage at the time of hiring, but also the future path of wages in the relationship.

The concept of the user cost of labor builds on the ideas of Barro (1977) and Hall (1980), among others, who argue that what matters to a firm is the value of wages to be paid during a firm-worker relationship. For example, Barro calls sticky wages just a "façade" of the implication of the long-term labor contracts during periods of short-term macro fluctuations. In the terms of Kydland and Prescott (1980), the weak procyclicality of real wage can suffer from ``cyclical measurement bias" because, with implicit contracts, wage payments are not perfectly associated with labor services provided each period. Indeed, what is relevant for the volatility of job creation and unemployment is the rigidity of the present discounted value of wages that firms expect to pay to a worker at the time of hiring, extended over the course of the employment relationship (Shimer 2004).

The User Cost of Labor

In employment relationships, labor is akin a long-term asset. The way to price a long-term asset, as we know from the study of physical capital, is by its rental price or user cost. The user cost of capital is the difference between the price of a unit of capital at the beginning of the period and the price at which the remainder of the unit, after depreciation, can be sold at the end of the period.

The user cost of labor, by analogy with the user cost of capital, is the difference between the expected present-discounted value of wages to be paid to a worker hired at the beginning of a period and the expected present-discounted value of wages to be paid if this worker were hired the following period (Kudlyak, 2014). In the case of labor, the appropriate discount rate includes an interest rate, but also the probability of job separation, which plays a role similar to capital depreciation.[2] Continuing the analogy of the user cost of capital, the user cost of labor reflects the value of "selling" the initial contract at the end of the period. The sale price of such a contract is the value of a new contract signed at the beginning of the following period.

The idea of the user cost of labor arises quite naturally when a firm evaluates the costs and benefits from adding labor.[3] Suppose that a firms-worker match can last indefinitely, but each period it faces some exogenous probability of separation. Consider a firm deciding between hiring a worker now versus postponing the hiring until the following period. Under either decision, the firm will have an equal number of workers from the following period onward, however, there is an additional worker in this period if the decision is to hire now versus later. As a result, the benefit of hiring now versus later is having a worker in this period. Consequently, the cost of this decision represents a price of having an extra worker work in this period---the price of labor. Because, as discussed above, hiring now versus later might have an impact on the entire wage path in the relationship, the cost of a decision

[2] Labor's depreciation can also be extended to include changes in labor's productivity within a match.
[3] See Appendix A for formal derivations.

to hire now is not simply the period hiring wage. Firms take into account the impact of hiring now on the path of future wages. The user cost of labor provides a way to capture such an impact.

Formally, to account for all the future costs and benefits of hiring now versus later, a firm compares (1) benefits and costs from a firm-worker match created now, versus (2) benefits and costs from a match created a period later. The costs include the expected present-discounted value of wages paid through the entire duration of the match as well as any match-creation costs, where the discounting takes into account a time discount factor as well as the probability of separation as mentioned above.

The benefit side of the firm's decision to hire in period t versus later simplifies to equal the output in period t. This is because from t+1 onward, the output in a match that starts in t or in t+1 is the same. This is by design of the firm's decision problem, whereby a firm considers hiring the same worker in t or in t+1, whose expected output from t+1 onward is the same in either t- or (t+1)-start match.

The cost side of this period-t output is the user cost of labor. It consists of the wage component of the user cost of labor and the non-wage component of the user cos of labor. The non-wage component encompasses costs of searching and finding a good match, as well as training or any other costs associated with creating a match. (These costs are not necessarily only upfront and can have a more complicated term structure.)

The wage component of the user cost of labor is the expected present discounted value of wages to be paid to a worker hired in period t minus the expected present discounted value of wages to be paid to a worker hired in t+1. As discussed above, in general, wages depend on the history of the labor market conditions from the start of the match. For example, in t+1, a worker hired in t might have a different wage than a worker hied in t+1. Therefore, the future wages in the relationships that start in t versus in t+1 might differ.

If the separation rate and discount rate do not depend on the history from the start of the match, the expression for the wage component of the user cost of labor in period t simplifies to the sum of hiring wage in t plus the expected present-discounted value of the differences from t+1 onward in wages in the match that starts in t and wages in the match that starts in t+1. This second term captures the impact of hiring in t on future wages in the relationship. If wages do not depend on history of economic conditions from the start of the match, then the expected future wages in the two relationships are equal and the user cost equals the hiring wage—which in turn equals the period's average wage. This, however, is generally not the case. The expression of the user cost of labor can be extended to allow for history-dependent separation rates.[4]

[4] With history-dependence in separation rates, the expected number of workers in a match in any future period depends on when each of the matches started. Kudlyak (2014) and Bils, Kudlyak and Lins (2023) derive an expression for the user cost of labor with history-depended discount factor. With history-dependent separation rates, in addition to the hiring wage in t plus the expected present-

Which Wage Matters for Firm Hiring Decisions

The Allocational Role of the Wage Component of the User Cost of Labor

Having introduced the user cost and, specifically, the wage component of the user cost of labor, I will demonstrate that it is the rigidity (or flexibility) of this statistic, and not of an average wage or of a new hire wage, that is relevant for firm decision-making about hiring.

From the discussion above it already follows that the firm's hiring decision involves comparing the output to the user cost of labor, and not to a one-period wage. That is, the wage component of the user cost of labor determines allocation, i.e., it plays an allocational role.

An intuitive way to see the allocational role of the wage component of the user cost of labor is to extend the framework described above by adding a condition that the firm will hire a quantity of labor in a given period up until the value of the decision of hiring now versus later is driven to zero. Such a zero-profit condition is a standard assumption in many models. It ties the period's output with the period's user cost of labor, the sum of the non-wage component and the wage component of the user cost of labor. The wage component is the allocational price of labor. At times, in this paper or elsewhere, we loosely refer to the wage component of the user cost of labor as simply the user cost, but it is the wage component that is the price of labor (in terms of wages).

Consider a textbook search and matching model (Mortensen and Pissarides, 1994). It can be shown that in such models, the zero-profit condition described above corresponds to a free entry condition (see Kudlyak, 2014), e.g., the firm will post vacancies until the value of such decision is driven to zero. The free entry condition equates the period's output to the sum of the wage component of the user cost and the non-wage component of the user cost, which in the model consists of the constant vacancy posting costs and the time-varying probability of filling a vacancy, which is a function of the vacancy-unemployment ratio. If the wage component of the user cost is rigid, then all changes in output must be channeled through changes in the non-wage component---specifically, through the probability of filling the vacancy via changes in vacancy-unemployment ratio. Furthermore, if the wage component of the user cost is rigid and constitutes a large fraction of output (e.g., profit is small), then even small changes in output can translate into large changes in the vacancy-unemployment ratio. If, instead, the wage component of the user cost responds to shocks to the extent similar to the response of output, then one needs to think of other mechanisms to generate large changes in the vacancy-unemployment ratio observed in the data.

The question how responsive to shocks, e.g., how cyclical, is the price of labor is an

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discounted value of the differences from t+1 onward in wages in the match that starts in t and wages in the match that starts in t+1, the wage component of the user costs of labor includes the expected present discounted value of wages to be paid in matches that start from period t+2 onward, weighted by the difference in the probabilities that there will be a need to create such a match to replace separated match in a position that starts in t versus in t+1.

empirical one. Of course, economists have built models that deliver rigid wage component of the user cost of labor using various mechanisms based on micro foundations. The key, however, is whether the rigidity of the wage component of the user cost of labor is supported in the data.

The concept of the wage component of the user cost of labor expresses the impact of the economic conditions at the time of hiring on future wages in terms of a current-period "flow value".[5] From the conceptual point of view, measuring labor's price by its user cost provides a convenient concept of a flow price of labor, which can be readily contrasted with individual wages or other prices such as the flow value of non-work, for example.[6] From the measurement perspective, as the sections below show, there are natural assumptions that allow setting the terms in the sum far into the future to zero, which simplifies the estimation.

How the Procyclicality of the Wage Component of the User Cost Can Be Masked by Seemingly Rigid Wages

As described above, the wage component of the user cost is the sum of hiring wage in t plus the expected present-discounted value of the differences from t+1 onward in wages in the match that starts in t and wages in the match that starts in t+1. Does accounting for these future terms---beyond the hiring wage---matter quantitatively for the estimation of the cyclicality of the wage component of the user cost? In this section, I provide an intuition of how seemingly rigid wages within employment relationships can mask a strongly procyclical wage component of the user cost of labor. In the sections below, I will show that it indeed matters empirically.

Consider an example of a wage-setting with history dependence: an insurance contract between a risk-averse worker and a risk-neutral firm (as in Thomas and Worrall 1988). Risk-averse workers dislike fluctuations in their wages. Thus, the firm insures the worker from business cycle fluctuations by offering a wage that remains fixed for as long as possible. For example, the firm and a worker might agree to split the joint surplus at the beginning of the match according to their respective bargaining weights and keep the wage constant until the value from the match to one of the parties becomes lower than that party's outside option. When the outside option binds, the wage in the relationship is adjusted just enough to prevent that party from leaving the match, provided the joint surplus is still positive.[7] Under such a wage-setting process, the wage under an ongoing

[5] If the present discounted value of wages to be paid in a match does not move over the business depending on when the match starts (e.g., is rigid), then the wage component of the user cost of labor is also rigid. This is because the wage component of the user cost is simply the difference between the present discounted values of wages paid in the relationships that start in the two consecutive periods. However, there are a few advantages of focusing on the cyclicality of the wage component of the user cost as opposed to on the cyclicality of the present discounted value of wages.

[6] Chodorow-Reich and Karabarbounis (2016) estimate that the flow opportunity cost of employment is procyclical and volatile over the business cycle.

[7] Typically, this kind of model also includes a search and matching friction or an exclusion restriction from the labor market prevent either side from walking away from the contract and getting an equivalent of a spot market wage.

contract is not necessarily equal to the wage that can be obtained under a newly signed contract.

In this setting, wages are smoothed—that is, wages are to some degree isolated from the business cycle fluctuations. In addition, wages depend on the history of labor market conditions at the start of the match. For example, the contracts that start during business cycle troughs, when the joint surplus is low, feature a lower stream of wages as compared to the contracts that start in economic booms, when the surplus is high. There is a lock-in to the initial business cycle conditions, at least for some period. Under such a wage-setting with history dependence, wages of newly hired workers are procyclical, while wages of workers in ongoing relationships are shielded from the business cycle fluctuations and are less procyclical or even rigid.

Consider a firm hiring in a business cycle trough when the new hire wages are low. Once a worker is hired, their path of wages remains relatively low, at least for some time, as compared to a worker hired later during recovery. The wage component of the user cost of labor is even lower than the actual new hire wage because it takes into account not only the low hiring wage but also the impact of the labor market conditions at the time of hiring on future wages. The opposite holds when a worker is hired in an economic boom --- the wage component of the user cost of labor is higher than the new hire wage because it takes into account the future higher wages in the relationship that starts in a boom. Consequently, if wages of workers in ongoing relationships are rigid and wages of newly hired workers are procyclical, we can expect the wage component of the user cost of labor to be even more procyclical than wages of newly hired workers.

Although this example is motivated by a model of implicit insurance contracts, the relevance of the user cost as a measure of price of labor does not hinge on the source of history dependence in wages. As another example, in macroeconomic models it is common to use a Calvo (1983) approach in which prices can only be changed at certain intervals, and so price adjustments in response to a shock do not happen all at once but are spread out over time. Calvo price-setting is history dependent and can be applied not just to labor markets but to prices across an economy, but it is not motivated by worker-firm insurance. Furthermore, the price of labor as measured by the user cost nests the case of wages with no history dependence.

Summarizing, if worker's wages exhibit substantial history dependence on the labor market conditions from the start of the match but are otherwise rigid, then a price of labor can be much more volatile than the new hire wage---much lower than the new hire wage if a worker is hired in a bust, and much higher than the new hire wage if a worker is hired in a boom. That is, rigid wage within employment relationships combined with a procyclical wage at the time of hiring can result in a pro-cyclical present-discounted value of wages to be paid in the match, and, therefore, a procyclical wage component of the user cost of labor.

Different Methods of Wage-Setting but the Same Volatility of the Wage Component of the User Cost --- A Demonstration of Allocational Role of the Wage Component of the User Cost

To illustrate how the wage component of the user cost of labor, and not wage, determines firm decisions about hiring, in Kudlyak (2014) I study a textbook search and matching model with four different methods of wage-setting. My goal was to study wage settings that, by design, allow for different degree of observed wage rigidity --- from completely rigid wages within a match to wages renegotiated each period.

I embed the self-enforcing worker-firm insurance contract of Thomas and Worrall (1988) in a search and matching model with risk-averse workers and risk-neutral firms. I distinguish three types of contracts based on the degree of commitment to the contract: full commitment contracts from both the firm and the worker, contracts with lack of commitment from the worker's side and full commitment from the firm's side, and contracts with lack of commitment from both the worker's and firm's sides. In the optimal contract with commitment, the wage remains constant within a match. In the contracts with lack of commitment, the wage remains constant until the value of the outside option for the party without commitment exceeds the value under the contract, in which case the wage is adjusted to prevent reneging. For comparison, I also study fourth method of wage-setting that involves Nash bargaining each period, in both new and existing job matches, as in the textbook search and matching model. I solve each of the four models and obtain the series of the wage component of the user cost of labor, wages of newly hired workers, wages of workers in ongoing relationships, and the vacancy-unemployment ratio. I then calibrate models' parameters such that each model delivers the same targeted cyclicality of the wage component of the user cost.

The simulation results from the four models show that once the cyclicality of the wage component of the user cost is calibrated to the same number across the models with different wage settings, the models generate similar volatility of the vacancy-unemployment ratio.[8] That is, the volatility of the wage component of the user cost of labor controls allocations in the models.

However, even though the cyclicality of the wage component of the user cost is calibrated to the same number across the models, cyclicality of individual wages and the wages of newly hired workers differ significantly across the alternative models of wage-setting. Specifically, in the three implicit insurance contract models, wages of newly hired workers are more procyclical than wages of workers in existing relationships. Average wages are least cyclical in the model with full commitment, more procyclical in the model with one-sided lack of commitment, and even more procyclical in the model with two-sided lack of commitment. In the model with full commitment, wages within employment relationships are rigid by assumption; and, therefore, the cyclicality of the average wage is due to the cyclicality of wages of new hires entering employment relationships. In the model with commitment on the firm's side and lack of commitment on the worker's side, in addition to the new hire wage cyclicality, the wages in the existing employment relationships are

[8] There are slight differences due to the curvature of the utility function with the risk-averse preferences of workers.

bid up whenever the workers' outside option value becomes more attractive than the value from the contract. In the model with lack of commitment on both the firm's and worker's sides, the wages can also be bid down whenever the value from the match for a firm falls below zero.

In the model with Nash bargaining each period in both new and existing matches, the wage component of the user cost of labor equals the new hire wage, which in turn equals the average wage. Consequently, under this wage setting, all three wage statistics—the new hire wage, the average wage, and the user cost of labor— share the same cyclicality.

Clearly, the behavior of individual wages in the models is just a façade. The allocations are determined by the behavior of the wage component of the user cost of labor.

Isolating the Cyclical Variation in the Labor's Price from the Cyclical Variation in Match Quality

One conceptual challenge in estimating the cyclicality of the price of labor from the data is distinguishing the true cyclical change in the price from the cyclical differences in the productivity of matches created at different points in the business cycle. Specifically, matches created at different points in the business cycle might systematically differ by worker productivity, firm productivity, or the interaction of firm-worker productivity. We refer to this productivity as "match quality." Note that this variation in match quality differs from the cyclical variation in the composition of workforce described earlier. Variation in the composition typically refers to the characteristics of a worker that can be controlled for by observables, like age or education. In contrast, match quality of the same worker might differ if the worker is matched with one firm versus with another, and can be a function of both the worker and the firm characteristics.

In estimating the cyclicality of the wage component of the user cost of labor we want to isolate the changes in the price of labor from any changes in match quality. The wage component of the user cost of labor is not directly observed in the data, because researchers observe only an actual path of wages of the hired worker and not a hypothetical expected wage path of the same worker if that person was hired in the following period. These expected would-be wage paths need to be inferred from the observed wage paths of the workers hired the following period. However, the matches created the following period might be of different quality than the matches created in the current period.

Note that the problem of disentangling the cyclicality of the price from the cyclicality of match quality is not specific to the estimation of the wage component of the user cost of labor; it also arises in estimating the cyclicality of wages of newly hired workers. Specifically, to estimate the latter we would like to measure what the change in the new hire age will be if the same worker was hired at different points over the business cycle. However, in practice, we have data on wages

of newly hired workers from different matches created in different periods over the business cycle and, potentially, of different quality.

Not accounting for the cyclical variation in quality of the matches can lead to a bias in the estimates of the cyclicality. For example, if the quality of matches created in recessions is typically higher than the quality of matches created in booms (e.g., if match quality is countercyclical), the higher quality will be reflected in relatively higher wage paths of the matches created in recessions. If not accounted for, this would bias the estimates of the cyclicality of the price of labor counter-cyclically (e.g., the estimates would show less procyclical wages than they really are).

A priori, it is not obvious whether match quality is pro- or countercyclical. For example, a greater availability of potential hires during recessions might increase the quality threshold for new matches, leading to creation of better matches and a counter-cyclical match quality. This view is consistent with what has been called "cleansing effect" of recessions (Caballero and Hammour 1994). Alternatively, matches created in recessions might be of a worse quality, perhaps because employers are more likely to be drawing on unemployed workers whose skills have depreciated. In that case recessions are sullying, and match quality is procyclical (for a model of sullying recessions, see Barlevy 2002). Ultimately, the cyclicality of match quality is an empirical question. I describe two widely-used approaches and a new approach of Bils, Kudlyak and Lins (2023) of how to control for match quality.

Approach #1: Wage Changes

One of the widely-used approaches of controlling for match quality in estimating the cyclicality of wages is based on looking at the cyclicality of wage *changes* (for example, Bils 1985; Gertler, Huckfeldt, Trigari 2020). Using individual worker panel data, the researcher calculates the change of worker's wage between the past period and the current period and estimates the cyclicality of this change. If this change is taken for wages within an employment relationship, the differencing takes out any match-specific fixed effects (such match-specific effects --- fixed for the short- or the medium-run --- within a match represent a typical concern in the match quality literature).

The issue arises when the wage change approach is applied to the new hire wage. In that case, typically, the change is calculated as the difference between the new hire wage in the current match and the most recent wage of the same worker, which is the last wage in the previous match that the worker was in (possibly prior to an intervening non-employment spell). There are two concerns here: first, the previous wage is not a new hire wage and is subject to all kinds of wage smoothing issues discussed above; second, most importantly, this approach implicitly uses the quality from the previous match as a proxy for the quality of the current match. Bils, Kudlyak and Lins (2023) provides a discussion of these issues in details.

In this approach, the estimate of the cyclicality of the new hire wage will be biased if the change in the quality between the two consecutive matches is correlated with the business cycle.

If workers tend to move to better-quality matches during economic recoveries (e.g., when unemployment falls), then the estimate of the cyclicality of new hire wages will be biased pro-cyclically. This might be the case for the job-to-job switchers, who typically move to better matches during recoveries. If, instead, workers move to lower-quality matches during recoveries, then the estimate of the cyclicality of new hire wages will be biased countercyclically. This might be the case for the new hires from unemployment during recoveries. These workers, having separated from their jobs during recessions, typically fall off the job ladder, search for jobs, and start climbing the job ladder anew.

Approach #2: Fixed effects

Another widely-used approach of controlling for match quality in estimating the cyclicality of wages is to control for individual worker fixed effects (for example, Kudlyak (2014) uses this approach). Individual worker panel data typically allow identifying worker fixed effects from observations on the same worker employed at different firms over time.

A worker fixed effect captures the average quality of all matches in which the worker in the panel has been observed. Implicitly, that average quality serves as a proxy for the quality of the current match. The intuition for the direction of the bias from this approach is similar to the one from the wage change approach. To the extent that during recoveries workers move to better than their-average-quality matches, this will bias the estimates of the new-hire wage cyclicality pro-cyclically. And, conversely, to the extent that during recoveries workers move to worse than their average quality matches, this will bias the estimates of the new-hire wage cyclicality counter-cyclically.

If a researcher has access not only to panel data but also to matched employer-employee data, such data allow controlling for both firm and worker fixed effects. These fixed effects are identified from observing the same worker employed at different firms and a firm employing different workers over time, respectively. These separate worker and firm fixed effects might not fully capture a joint effect of worker-firm match quality. However, using a joint worker-firm match fixed effect for estimating the cyclicality of the new hire wage leads to the same biases as using simply a worker fixed effects --- the fixed effects are calculated as an average over different matches.

Approach #3: The match's long-run wage

The long-run wage in the same match can be uses as a proxy for the new hire match quality (Bellou and Kaymak, 2020; Bils, Kudlyak and Lins, 2023). Under this approach, the long-run wage in the same match is differenced out from the new hire wage. Such differencing takes care of any quality of a match that is fixed throughout the match—which is a concern of most of the match-quality literature.

The issue may arise if the quality of a match evolves during the match and its evolution is correlated with the economic conditions at the start of the match. Specifically, if quality of the match grows during the course of the match *and*, importantly, this growth is greater in the matches that start in recessions versus booms, the estimates of the cyclicality of the new hire wage might be biased pro-cyclically. Bils, Kudlyak and Lins (2023) perform multiple robustness exercises to check whether matches that start in recessions display disproportionally greater growth of quality within the match, either fundamentally or via selection in the matches that survive to our definition of the long run of eight years, as compared to the matches that start in booms. They find only mild evidence of selection.

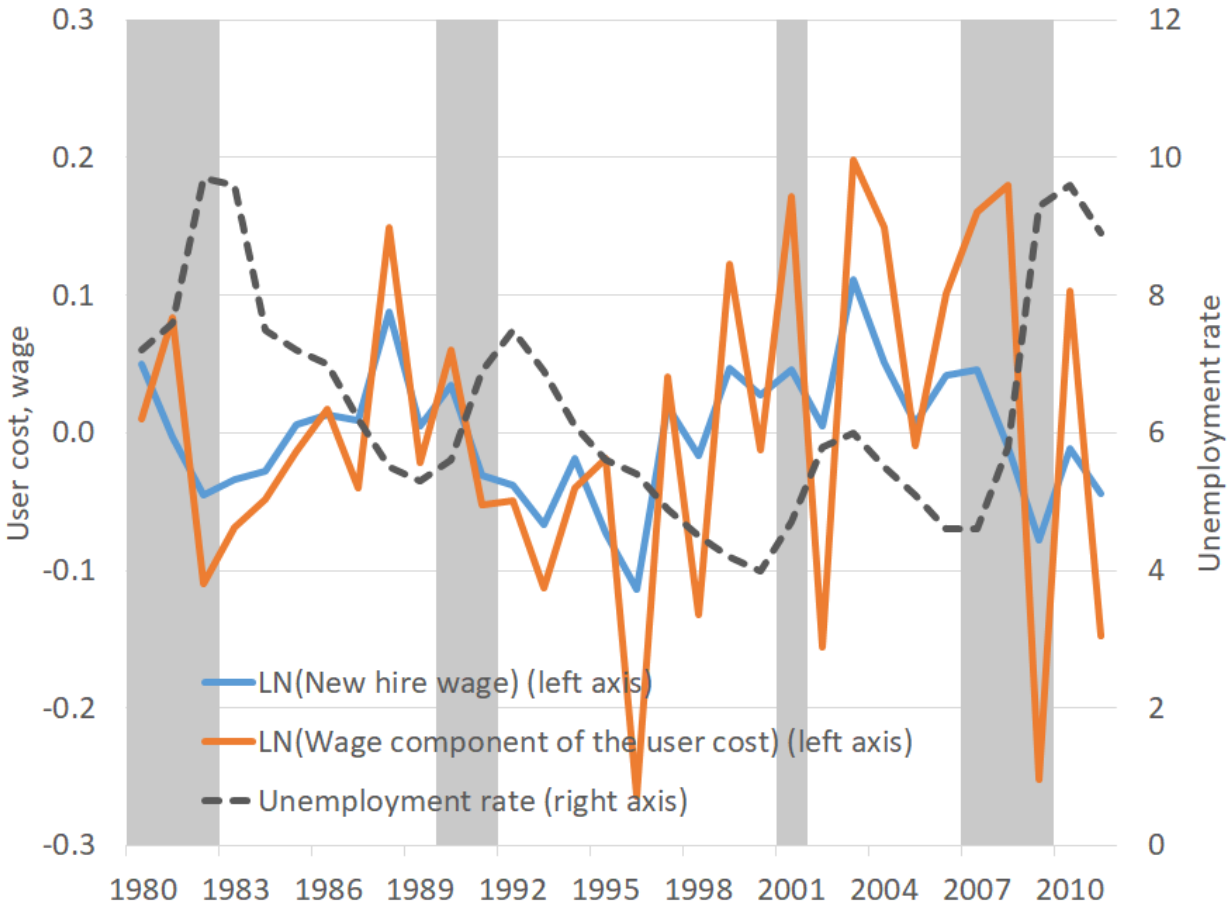
Estimates of the Cyclicality of the Price of Labor

Up to this point, we have focused on the conceptual issues involved in estimating and interpreting the user cost of labor: thinking about implicit long-term contracts, where wages are smoothed and the economic conditions at the time of hiring (say, during a recession or a recovery) may have an impact on the entire future path of wages in the relationship, and also thinking about a need to adjust for the possibility that matches created at different points of the business cycle can be of different quality. What happens when you put all these ingredients together and carry out an actual estimate?

Bils, Kudlyak and Lins (2023) estimate the cyclicality of new hire wages and of the wage component of the user cost using individual worker wage data from the National Longitudinal Surveys, the NLSY1979 and NLSY1997, spanning 1980 to 2019. They construct the empirical counterpart of the wage component of the user cost based on the behavior of individual wages and turnover.

First, they construct a measure of the real wages for new hires after doing an adjustment for match quality, using (as discussed above) the expected long-run wage of a match as proxy for firm-worker match quality. Second, for each year in their sample period, they calculate the job separation rate conditional on the year when the match starts. Third, using the quality-adjusted wages and the job separation rates, they construct 32 annual observations of the wage component of the user cost of labor, from 1980 to 2011. Each observation involves calculating the expected wage path eight years out, and they explore a variety of assumptions about time variation in the separation rate and the appropriate time discount factor. Fourth, they investigate whether this measure of the user cost is cyclical, by regressing the log of the user cost of labor on the unemployment rate and a cubic trend. Figure 2 shows the quality-adjusted new-hire wage and the wage component of the user cost of labor with time-varying and history-dependent separation rate and discount factor from Bils, Kudlyak and Lins (2023).

Figure 2. The New-Hire Wage and the User Cost of Labor



Notes. The figure shows the quality-adjusted new-hire wage and the wage component of the user cost of labor with time-varying and history-dependent separation rate and discount factor (left axis). The series are in logs and are normalized to average zero for the sample period (e.g., 0.1 means 10 percent above sample-period mean). The unemployment rate (right axis) is in percentage points. All series are annual. Shaded areas mark the NBER-dated recessions. Source: Bils, Kudlyak and Lins (2023).

Bils, Kudlyak and Lins (2023) estimate that the quality-adjusted wage of new hires decreases by 2.35 percent when unemployment goes up by one percentage point. It is nearly as cyclical for hires from non-employment as for those moving job-to-job. (This finding, like all others mentioned here, is statistically significant.)

Bils, Kudlyak and Lins (2023) next calculate the wage component of the user cost of labor, under various assumptions of the time variation in the separation rates and discount factors, and estimate its cyclicality. Under all these various assumptions they find that the wage component of the user cost of labor is strongly procyclical. Specifically, with a constant separation rate and discount rate, a percentage point higher unemployment rate is associated with a 4.81 percent decline in the wage component of user cost. With the separation rates that vary both with the

current year and the match's start year and the time-varying discount factor, their benchmark estimate, the wage component of the user cost of labor declines by -5.32 percent when the unemployment rate increases by one percentage point. Its estimated elasticity with respect to real GDP is around 2.6.

Finally, Bils, Kudlyak and Lins (2023) note that that matches created in recessions typically last shorter than the matches created in booms, e.g., that the durability of matches by the match start date is procyclical (see, among others, Bowlus 1995; Mustre Del Rio 2019; Baydur and Mukoyama 2020). If the new hires that start in recessions display systematically higher separation rates, then firms that hire in recessions will eventually need to spend more on hiring to create replacement matches. Such higher expected turnover costs might be reflected in the lower wages of matches that start in recessions. Therefore, Bils, Kudlyak and Lins (2023) calculate how much less procyclical the wage component of the user cost of labor would be if the countercyclicality of these hiring costs is taken into account. To do this, they adjust the cyclicality of the wage component of user cost of labor to compensate for the "excess" counter-cyclicality of the non-wage component of the user cost that arises due to the procyclical expected durability of matches.[9] Depending on the assumption about the non-wage costs, the adjusted cyclicality of the price of labor is between -4.21% and -4.79%. Comparing these estimates to the one without adjustment, -5.32%, reveals that adjusting for match durability reduces the cyclicality of the wage component of the user cost by only about a fifth, even generously calibrating hiring and training costs.

In short, Bils, Kudlyak and Lins (2023) find that the price of labor is strongly procyclical, driven by a combination of procyclicality of new-hire wages as well as the procyclicality of the effect of locking-in of the future wages in the relationship to the economic conditions at the time of hiring. A 2.3 percent reflects a procyclical new-hire wage. Another 3 percent reflects a ``lock-in" effect on future wages---a total wage effect of approximately 5.32 percent. And, finally, this large procyclicality is somewhat offset by shorter durability of matches that start in recessions.

This estimate of the cyclicality of the price of labor is quantitatively similar to other recent studies that estimate the cyclicality of the price of labor by its user cost. Kudlyak (2014), Basu and House (2016), Doniger (2021) and Maruyama and Mineyama (2021) find that the price of labor is strongly procyclical, more procyclical than new-hire wage or the average wage.

[9] Bils, Kudlyak and Lins (2023) consider two different scenarios for the non-wage costs associated with adding a worker. Under the first scenario, a hiring cost is incurred in the starting period and equals to three months of wages. This is relatively large relative to typical values in the literature (for example, as compared to the costs calculated by Silva and Toledo (2013) for hiring and training). Under the second scenario, the non-wage component includes, in addition to the upfront costs, persistent training costs that decline over the match such that the expected discounted value of the flow of the non-wage costs is 0.96 of a full year of steady-state earnings.

Implications for Volatility of Employment

The estimated procyclicality of the wage component of the user cost of labor has direct implications for the volatility of employment in the models. It is intuitive to examine the implications in the context of the textbook search and matching model mentioned above. The model's free entry condition ties labor's productivity to the sum of the wage component of the user cost of labor and the non-wage component, which is a function of the vacancy-unemployment ratio. As discussed earlier, if the wage component of the user cost of labor is rigid, then any changes in productivity is channeled via the changes in the vacancy-unemployment ratio. In this sense, the free entry condition imposes a trade-off between the elasticity of the wage component of the user cost of labor and the elasticity of the vacancy-unemployment ratio with respect to productivity.

Having estimated the cyclicality of the wage component of the user cost of labor, we can check whether the trade-off between the volatility of the wage component of the user cost of labor and of the vacancy-unemployment ratio imposed by the model's free entry condition holds in the data. It turns out that the restrictions imposed by the model's free entry condition do not hold in the data (see Kudlyak (2014) for details). Specifically, the cyclicality of the wage component of the user cost of labor of above 4 percent translates into the elasticity with respect to productivity of well above 1.5 or even above 2, depending on the sample period. Under the standard parameter values employed in the literature, the model's free entry condition cannot simultaneously accommodate the high empirical elasticity of the wage component of the user cost and the high empirical elasticity of the vacancy-unemployment ratio. That is, in the data, when productivity declines, both the price of labor and the vacancy-unemployment ratio decline so much that the free entry condition does not hold. It is as if another force in the model is needed to counter these declines to make the condition hold.

The estimated cyclicality also has a direct implication for the unemployment volatility puzzle. Specifically, Shimer (2005) points out that in the context of a textbook search and matching model, the observed shifts in productivity are not large enough to generate the observed fluctuations in the vacancy-unemployment ratio. Rigid price of labor is one of the seemingly straightforward solutions. However, the strongly procyclical estimates of the wage component of the user cost of labor imply that not only the data lack rigidity to amplify the volatility of the vacancy-unemployment ratio in the model, but also the price of labor and the vacancy-unemployment ratio are too volatile for the free entry condition in the standard search and matching model to hold. Consequently, the solution to the unemployment volatility puzzle cannot be explained by a wage formation alone because any wage formation should be able to match the empirical volatility of the wage component of the user cost of labor.

The distinction between the empirical cyclicality of the wage component of the user cost of labor and of the new hire wage or the average wage is crucial for the conclusion on the propagation of shocks. In the textbook search and matching model, wages are typically set by Nash bargaining every period, in new and existing matches. In a model with such a wage setting, the wage component of the user cost equals the new hire wage which in turn equals the average wage. In the

data, these three wage statistics display vastly different cyclicality --- from strongly procyclicality of the wage component of the user cost of labor to almost rigid average wage. Which of the three empirical cyclicality does the model's wage component correspond to? The empirical counterpart of the wage cyclicality of a model with Nash bargaining is the cyclicality of the wage component of the user cost of labor in the data. Nash bargaining each period in all matches serves as a convenient modeling device that delivers a closed-form solution of the wage component of the user cost of labor, but it does not capture history dependence in wages found in the data. Focusing on the cyclicality of individual wages might lead to a misleading assessment of the quantitative behavior of the model if the wage formation is specified incorrectly.[10] Importantly, the firm's free entry condition imposes the restriction on the wage component of the user cost of labor, not wage per se.

If one disciplines a model by its cyclical price of labor, the corresponding data moment is the wage component of the user cost of labor, regardless of whether the model generates history dependence in wages. The correct empirical counterpart is especially consequential because in the data a researcher faces a menu of different wage measures---that of an average wage, new hire wage and the user cost---which range from rigid to strongly procyclical.

Future Work

To understand the implications of the of the procyclicality of the price of labor, consider, for example, the 2007-09 recession when between 2007 and 2009, the unemployment rate went up by 3.5 percentage points relative to its (cubic) trend. By Bils, Kudlyak and Lins (2023) estimates, during this time, the estimated price of labor went down by 18.6 percent, a sizeable decline; and more than twice greater than the decline in the new hire wage. Such strongly pro-cyclical price of labor suggests that it is relatively cheap to hire in recessions. These results suggest that wage rigidity cannot be the primary cause of cyclical fluctuations in employment. The strong procyclicality of the price of labor suggests that other forces must be at play behind the cyclical

[10] Using the cyclicality of the average wage instead of the cyclicality of the wage component of the user cost of labor might lead to an erroneous conclusion that data have the required wage rigidity to solve the unemployment volatility puzzle. For example, in theory, a model with a high flow value of unemployment can generate the empirical volatility of the vacancy-unemployment ratio (see Hagedorn and Manovskii, 2008). The high flow value of unemployment renders the price of labor in the model to be a large fraction of the output. However, ultimately, the approach rests on the rigidity of the price of labor. The key to whether this approach has support in the data is how rigid the price of labor is. Calibrating the price of labor from the model to the elasticity of the average wages might create an illusion of such rigidity; however, the empirical counterpart of the price of labor is the wage component of the user cost which is much more procyclical. In fact, there is no value of the unemployment benefits parameter in the set of its feasible values so that the model's free entry condition simultaneously accommodates the high empirical elasticities of the vacancy-unemployment ratio and of the wage component of the user cost of labor (see Kudlyak, 2014).

fluctuations in labor demand (for an example, see recent work by Kehoe, Lopez, Midrigan, and Pastorino, 2023).

With regards to the measurement of the cyclicality of the price of labor, one direction of future research is examining the cyclicality of the price of labor on the intensive margin. Another promising direction is to examine heterogeneity in the cyclicality of the price of labor across different occupations or, more broadly skill groups. For example, Doniger (2021) estimates more cyclical user cost for college-trained workers compared with those without a college education. Another direction of research is examining the cyclicality of the price of labor faced by different firms. Different firms face different costs of financing, especially during recessions, which might affect their discount factor and, consequently, the cyclicality of the price of labor that they face. Recognizing the procyclical nature of the price of labor—appropriately understood as the user cost of labor—is re-opening fundamental questions about the functioning of labor markets.

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1 APPENDIX A: Derivation of the User Cost of Labor

Consider a firm deciding between hiring a worker in period t versus postponing the hiring till $t+1$. Under either decision, there is an equal number of workers from $t+1$ onward, but an additional worker in t if the decision is to hire in t. Consequently, the benefit of hiring in t versus later is having a worker work in t. The cost of that decision is the user cost of labor in t.

The firm's expected present-discounted value of hiring a worker in t, J_t, is

$$J_t = -\kappa_t + E_t \sum_{\tau=1}^{\infty} \big(\beta(1-\delta)\big)^{\tau} \big(z_{t+\tau} - w_{t,t+\tau}\big), \tag{1}$$

where κ_t is costs associated with hiring a worker in t, $z_{t,t+\tau}$ is the marginal revenue product of the match in $t+\tau$, $w_{t,t+\tau}$ is the wage paid in $t+\tau$ in the match that started in t, β is the time discount factor and δ is the separation rate.

The firm's expected value from creating a match in t versus creating a $(1-\delta)$ of a match in $t+1$[1] is

$$\begin{aligned} J_t - \beta(1-\delta)E_t J_{t+1} = & \underbrace{z_t}_{\text{benefit}} - \underbrace{\big(\kappa_t - \beta(1-\delta)\kappa_{t+1}\big)}_{\text{non-wage component of the user cost, } UC_t^{\kappa}} \\ & \underbrace{- \big(w_{t,t} + E_t \sum_{\tau=1}^{\infty} \big(\beta(1-\delta)\big)^{\tau} \big(w_{t,t+\tau} - w_{t+1,t+\tau}\big)\big)}_{\text{wage component of the user cost, } UC_t^{W}} \\ & = z_t - (UC_t^{\kappa} + UC_t^{W}) \\ & = z_t - UC_t. \end{aligned} \tag{2}$$

Equation (2) states that the firm's expected value from creating a match in t versus in $t+1$ equals the output in t minus the cost of that output— the user cost of labor, UC_t.

The user cost of labor consists of two components: the wage component, UC_t^W, and the non-wage component, UC_t^{κ}. The non-wage component encompasses hiring costs and can be extended to incorporate training or any other costs associated with creating a match.

The wage component of the user cost of labor is the price of labor, e.g.,

$$UC_t^W = w_{t,t} + E_t \sum_{\tau=1}^{\infty} \big(\beta(1-\delta)\big)^{\tau} \big(w_{t,t+\tau} - w_{t+1,t+\tau}\big). \tag{3}$$

We can extend the model described above by adding a condition that the perturbation described in equation (2) delivers a value of 0, e.g., $J_t - \beta(1-\delta)E_t J_{t+1} = 0$. Using equation (2), this yields

$$z_t = UC_t^{\kappa} + UC_t^{W},$$

[1] Creating a $(1-\delta)$ of a match in $t+1$ takes into account that a match created in t survives till $t+1$ with probability $(1-\delta)$. It ensures that from $t+1$ onward there is an equal number of workers in both a t-start and a $t+1$-start match.

or, alternatively,

$$z_t = \big(\kappa_t - \beta(1-\delta)\kappa_{t+1}\big) + \underbrace{\big(w_{t,t} + E_t \sum_{\tau=1}^{\infty} \big(\beta(1-\delta)\big)^{\tau} \big(w_{t,t+\tau} - w_{t+1,t+\tau}\big)\big)}_{\text{wage component of the user cost, } UC_t^W}. \tag{4}$$

Intuitively, firms hire in t versus $t+1$ until the value of such a decision is driven to 0. It follows from equation (4) that the wage component of the user cost of labor, and not wage, determines allocations.